ARIZONA TRANSPORTATION RESEARCH CENTER

RESEARCH NOTES:

Project 503

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"State-of-the-Art" Report on Non-Traditional Traffic Counting Methods

Highlights

- States are required to record traffic volumes, vehicle classification, and vehicle weight data.
- This information provides documentation to ensure the State receives appropriate levels of federal funding.
- It also aids in the design of highway improvement projects.
- The type of traffic data collection devices available on the market has changed little in the past decade.
- Less than half of all State DOTs are using non-intrusive methods for gathering traffic data.
- Inductive loops are probably the most consistently accurate device for vehicle counting applications.
- However, the newer non-intrusive technologies show great promise.
- There is a new focus in the industry to develop reliable, non-intrusive devices that are easy to use and cost effective to operate.

Background

The Federal-Aid Policy Guide established by the Federal Highway Administration mandates "requirements for development, establishment, implementation, and continued operation of a traffic monitoring system for highways and public transportation facilities and equipment in each State." Subchapter F of the Federal-Aid Policy Guide outlines general requirements for compliance with this policy. States must comply with these requirements when traffic data generated by the state are used for the following purposes:

- Traffic data are used in support of studies or systems which are the responsibility of the U.S. Department of Transportation;
- Collection of traffic data is supported by the use of Federal funds;
- Traffic data are used in the apportionment or allocation of Federal funds;
- Traffic data are used in design or construction of an FHWA funded project; or

- Traffic data are required as part of a federally mandated program.

A State's traffic monitoring procedures also apply to the "activities of local governments and other public or private non-State government entities collecting highway traffic data within the State" if the data are used for any of the purposes described above. Since participation in federally-funded programs is essential to the integrity of a State's highway systems, the accurate, efficient collection of traffic data becomes a critical component of transportation infrastructure management.

As part of a traffic monitoring system, States are required to record traffic volumes, vehicle classification, and vehicle weight data. This information is collected at short-term counting stations and at long-term, continuous counting stations. Short-term counts are then adjusted for seasonal, day-of-the-week, and other factors as assessed at continuous count stations to provide estimates of traffic patterns throughout the State's highway infrastructure. This information provides documentation to ensure the State receives appropriate levels of federal funding to maintain or expand its highway system. It also aids in the design of highway improvement projects.

Decisions made regarding upgrades to traffic counting practices should be based on accurate, up-to-date information. This report summarizes the current state-of-the-art in traffic enumeration devices to facilitate this decision making process.

Approach

This report is comprised of three components—an evaluation of current technology, a literature review, and a survey of State Department of Transportation (DOT) practices. The first section summarizes information supplied by manufacturers of devices used to collect count, speed, classification, and/or weight-in-motion data. Each manufacturer was asked to provide information regarding sensor technology, applications, classification algorithm, lane-monitoring capability, price, installation requirements, telemetry, calibration, power requirements, temperature requirements, and limitations of the system for each product.

The second section contains the results of the Traffic Counting Survey circulated to the fifty State DOTs. Results were compiled in an Access database and summarized into tables for display in this report. The survey is included as Appendix A. Individual results from each state are included in Appendix B.

The last section contains information gathered through a review of books, journals, Internet websites, and interviews with traffic counting professionals. Due to rapid advances in the area of traffic management, the review was limited to information from the past five years. A bibliography of relevant journal articles and websites dealing with traffic counting devices and transportation technology is included as Appendices C and D.

Findings

The type of traffic data collection devices available on the market has changed little in the past decade. The same thirteen technologies are still being utilized by State, county, city, and metropolitan organizations responsible for traffic monitoring operations. Some products have come and gone off the market and companies have been bought and sold, but the science remains pretty much the same.

This is not to say the industry has been at a stand still. The devices have evolved as their use has come under greater scrutiny with increased

usage. But, the increased usage has been more likely due to the recent focus on "intelligent transportation systems" (ITS) and the use of these devices in support of this movement. This is particularly true in the area of advanced traffic management systems (ATMS) where video image detection, Doppler microwave, passive magnetic, and passive acoustic technology are being used for signalized intersection control, incident detection and management, speed traps, and freeway metering control. As the need for collection of accurate, reliable traffic data is realized as essential for allocating scarce resources to support an aging infrastructure, greater pressure will be placed on manufacturers to make the existing technology used for traffic data collection more efficient and cost-effective.

Less than half of all State DOTs (24 out of 50) are using non-intrusive methods for gathering traffic data. This may be due to the lack of comparative data showing the accuracy of these new technologies as compared to standard road tubes, inductive loops, and piezo-electric sensors. Other factors contributing to the reluctance to convert to non-intrusive technology may be cost and the level of technical expertise required to operate the devices. Both issues were addressed in Section 2.0.

Inductive loops are probably the most consistently accurate device for vehicle counting applications. However, the newer non-intrusive technologies show great promise. As they show increased usage, they will continue to evolve and improve. Unfortunately, manufacturers cannot afford to invest in the research and development needed to continue to improve these devices without the assurance that a tangible market for their product exists. Additional cooperative studies validating the accuracy, reliability, and cost-effectiveness of these devices need to occur so that both groups will benefit.

The state-of-the-art of traffic counting devices is changing rapidly. There is a new focus in the industry to develop reliable, non-intrusive devices that are easy to use and cost effective to operate. However, there is much to be learned through the experiences of those who have evaluated these devices. It is recommended that the reader obtain the documents listed in the report on this project to learn from the experiences of those who have installed and operated these devices in the field. The documents provide valuable practical information that can only be gained from working directly with the equipment.

Table 4. Limitations of the Technology

Sensor Technology		Limitations
Intrusive Devices	bending plate	• Installation requires working within the traffic lane • Equipment time consuming to install • Equipment expense high
	pneumatic road tubes	• May become displaced resulting in loss of data • Installation requires working within the traffic lane • Snow plows can damage road tubes • Limited lane coverage
	piezo-electric sensor	• Installation requires working within the traffic lane • If place on road surface, may become displaced resulting in loss of data • If imbedded in roadway, requires disruption of road surface integrity potentially decreasing the life of the pavement • Sensor installation may be compromised by old asphalt or concrete
	inductive loop	• Installation requires working within the traffic lane • Requires disruption of road surface integrity potentially decreasing the life of the pavement • Sensor installation may be compromised by old asphalt or concrete • Prone to installation errors that lead to high maintenance requirements [3] • Susceptible to damage by heavy vehicles, road repair, and utilities [3] • Potentially short life expectancy
Non-Intrusive Devices	passive/active infrared	• Lane coverage limited to one to two lanes • Active infrared sensors are generally limited to the same range in inclement weather as can be seen with the human eye [4] • Active infrared classification based on vehicle height rather than length • Passive infrared performance potentially degraded by heavy rain or snow [3]
	passive magnetic	• Difficulty in discriminating longitudinal separation between closely spaced vehicles
	Doppler microwave	• Unable to detect non-moving traffic • Difficulty in differentiating adjacent vehicles • Overhead installation requires the presence of existing structure for mounting the device
	radar	• Side-fire installation limited to only long and short vehicle classification • Overhead installation requires the presence of existing structure for mounting the device
	ultrasonic	• Performance may be degraded by variations in temperature and air turbulence [3]
	passive acoustic	• Signal processing of energy received requires removal of extraneous background sound and acoustic signature to identify vehicles [3]
	video image detection	• Overhead installation requires the presence of existing structure for mounting • Weather conditions that obstruct view of traffic can interfere with performance (i.e., snow, fog, sun glare on camera lens at sunrise and sunset • Large vehicles can mask trailing smaller vehicles

The full report *"State-of-the-Art" Report on Non-Traditional Traffic Counting Methods* by Sherry L. Skszek (Arizona Department of Transportation, report number FHWA-AZ-01-503, published October 2001) is available from the Arizona Transportation Research Center, 206 S. 17 Ave., mail drop 075R, Phoenix, AZ 85007; phone 602-712-3138.